REMARKS

This is intended as a full and complete response to the Final Office Action dated April 28, 2011. Claims 1, 8, 23, 25, 27, 45, 47, 49, 51 and 59 have been amended and new claim 69 has been added to more clearly recite various aspects of the invention. Applicants believe no new matter has been introduced by the amendments and the new claim presented herein. The amendments have been made to put the claims in condition for allowance or in better condition for an appeal. Please reconsider the claims pending in the application for reasons discussed below.

In a telephone interview on August 25, 2011, claims 25, 45, 49 and 59 were discussed with the Examiner. During the interview, the Examiner indicated that she will have to perform an updated search. Applicants appreciate the Examiner's courtesy for scheduling and conducting the interview.

Claims 1-3, 9-15, 18, 19, 22, 25, 27, 28, 30, 39-46, 49, 54, 55, 59, 63 and 66 stand rejected under 35 U.S.C 103(a) as being unpatentable over U.S. Patent No. 6,691,038 ("Zajac") in view of U.S. Patent no. 6,590,831 ("Bennett"). Zajac is generally directed to an active control system for a towed seismic streamer array that enables relative positional control of towed seismic streamers. (See Zajac, Abstract). Bennett is generally directed to a system for coordinating the operation of multiple vessels engaged in marine seismic data acquisition. (See Bennett, Abstract). Claim 1 has been amended to now include "wherein the navigation data comprise vectors of position, velocity and acceleration." Claim 25 has been amended to now include "wherein the desired coordinate positions achieve a target shape for the seismic survey spread elements." Claim 45 has been amended to now include "controlling a shape of the seismic survey spread by coordinating the positioning of the vessel control elements, the source control elements and the streamer control elements." Claim 49 has been amended to now include "controlling a shape of the seismic survey spread by coordinating the positioning of the streamer control elements and the source control elements." Claim 59 has been amended to now include "controlling a shape of the seismic survey spread by coordinating the positioning of the vessel control elements, the source control elements and the streamer control elements." Support for the

amendments may be found throughout the specification including page 18, lines 16-18, page 29, lines 17-18 and claim 27. Neither Zajac nor Bennett teaches these limitations.

With regard to navigation data in claim 1, the Examiner points to Zajac in column 2, lines 5-59. (See Office Action, page 5). The relevant portion of Zajac is reproduced below for the Examiner's convenience.

> There is no known seismic tracking and positioning system that enables independent and relative positioning of individual seismic streamer array elements, for example "birds", seismic streamers, comprising sensors, sources and depth and position controls, for example to configure, manipulate and/or maintain a desired geometry of and within a towed seismic streamer array. There is also no known seismic tracking and positioning system that enables relative positioning and manipulation of an entire seismic streamer array. There is also no known tracking and positioning system that enables specification of a plurality of diverse acquisition and ancillary non-acquisition array geometries that facilitates run-time maintenance, retrieval and deployment of a towed seismic array. Moreover, there is no known seismic tracking and positioning system that tracks the geometry of the seismic streamer array and the relative positions of the individual streamers comprising array elements with respect to time and with respect to the earth's latitude and longitude so that towed seismic array data acquisition runs are repeatable, thereby enabling acquisition of four-dimensional geophysical data (x, y, z, time).

> Thus, there is a need for a seismic acquisition tracking and positioning system that overcomes the above-mentioned shortcomings of known seismic data acquisition tracking and positioning systems. There has been a long-felt need for an efficient and effective towed marine seismic tracking and positioning system having system components that are easily and reliably tracked, controlled and positioned. There has also been a long-felt need for seismic data acquisition towing, tracking and positioning systems to provide sufficient positioning flexibility to enable efficient, accurate, and repeatable control of the relative and absolute horizontal and vertical positions of towed arrays and the streamers, sensors and sources within a towed array during seismic data acquisition.

SUMMARY OF THE INVENTION

> The present position invention provides a method and apparatus for an active tracking and positioning system for a towed seismic streamer array. The present invention recognizes and addresses the previously mentioned shortcomings, problems and long-felt needs associated with known towed seismic tracking and positioning systems. The present invention provides

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> a solution to the aforementioned problems and provides satisfactory meeting of those needs in its various embodiments and equivalents thereof.
>
> The active tracking and positioning system of the present invention provides a method and apparatus that enables relative positional control of any number of towed seismic streamers. The present invention controls streamer positions horizontally and vertically using active control units positioned on each streamer within the seismic array. **The three component (x, y, z) position of each streamer element, relative to the vessel, relative to each other and relative Earth coordinate latitude and longitude is controlled, tracked and stored** with respect to time during each seismic data acquisition run.

(Zajac, column 2, lines 3-59, Emphasis Added)

As shown above, Zajac does not teach navigation data that comprise vectors of position, velocity and acceleration, as recited in claim 1. In contrast, Zajac merely mentions tracking three component (x, y, z) position coordinates (i.e., position vector) of each streamer element. In this manner, Zajac does not use vectors of position, velocity **and** acceleration for its navigation data. Bennett also fails to teach this newly added limitation.

With regard to claims 25, 45, 49 and 59, neither Zajac nor Bennett teaches achieving a target shape for a seismic survey or controlling a shape of the seismic survey. This limitation is recited in claim 27. As to claim 27, the Examiner takes the position that Zajac teaches achieving a target shape and track for the seismic survey spread elements in column 8, lines 1-38. The relevant portion of Zajac is reproduced below for the Examiner's convenience.

> The array, streamer and individual ASPD three-component (x, y, z) position data with respect to time is stored along with real time environmental data. Environmental data is received via cable or radio from sensors deployed from the vessel or the array. The stored position and environmental data is stored as legacy data in the legacy data storage 22. Optimal path data, is generated by Optimal path processor 24, which may be generated by a neural network or some other methodology such as human input or mathematical formulae, is input to master controller 26. **Optimal path data may be provided as a desired seismic acquisition path** during primary seismic data acquisition or during in fill shooting. Optimal path data steering is preferably divided between an optimal path

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for the tow vessel 10 and an optimal path for the towed array. During seismic data acquisition utilizing an optimal path 24, vessel, array, array element and ASPD positions are sensed along with environmental data are transmitted to and received by the data acquisition unit 21. The data acquisition unit 21 stores these inputs with respect to time as legacy data in the legacy data storage 22. The data acquisition unit 21 also passes the array and environmental tracking data to the master controller 26. The maneuverability of the particular cable, ASPD and vessel under the particular sensed environmental conditions are also factored into the active positioning commands. For example, a cable that becomes stiffer in colder water or more buoyant in higher salinity receives an augmented steering command depending on the sensed environmental data. Master controller 26 compares the current vessel and array position data with the desired position or optimal vessel and array path position. The master controller 26 then determines, in light of the current environmental conditions and the maneuverability of the vessel, ASPDs and towed streamers comprising the array, the timing and magnitude of positioning commands to be sent to the ASPDs on the array. The positioning commands are formatted and transmitted by active position commander 28 over link 30. Link 30 may be hardwired or wireless via satellite, laser or radio link.

(Zajac, column 8, lines 1-38, Emphasis Added).

As shown above, Zajac does not teach achieving a target shape for a seismic survey or controlling a shape of the seismic survey, as recited in claims 25, 45 and 49. In contrast, Zajac merely teaches achieving a seismic acquisition path. A path is generally defined as a route, course, or track along which something moves. (See http://dictionary.reference.com/browse/path). In this manner, Zajac's path describes a route along which its vessels move. The seismic acquisition path is not the same as a shape of a seismic survey. Applicants' specification clearly distinguishes between the shape of a spread and a track when it describes its optimum track as including an optimum spread body **shape** and a corresponding shape change **along a track** (i.e., path). (See specification, page 29, lines 17-18).

New claim 69 has been added to further clarify the plurality of seismic survey spread elements, recited in claim 25, as comprising one or more streamers. Support for the new claim may be found throughout the specification, including page 6, lines 6-14. Neither Zajac nor Bennett teach wherein the desired coordinate positions achieve a target shape for the plurality of seismic survey spread elements, and wherein the

plurality of seismic survey spread elements comprise one or more streamers, as recited in claims 25 and 69.

For these reasons, claims 1, 25, 45, 49 and 59 are patentable over Zajac and Bennett. Claims 2-3, 9-15, 18, 19, 22, 27, 28, 30, 39-44, 46, 54, 55, 63 and 66 are also patentable over Zajac and Bennett, since they depend from claims 1, 25, 45, 49 and 59, respectively. Withdrawal of the rejection is respectfully requested.

Claims 4, 5, 7, 16 and 53 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Zajac in view of Bennett and further in view of US Patent No. 6,618,321 ("Brunet"). Claim 6 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Zajac in view of Bennett and further in view of US Patent No. 4,862,425 ("Cretin"). Claim 8 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Zajac in view of Bennett and further in view of US Patent No. 5,448,233 ("Saban"). Claims 17 and 23 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Zajac in view of Bennett and further in view of US Patent No. 7,446,706 ("Riley"). Claim 20 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Zajac in view of Bennett and further in view of Gikas et al, "Reliability analysis in dynamic systems: Implications for positioning marine seismic networks", *Geophysics*, Vol. 64, No. 4, July-August 1999, pgs. 1014-1022 ("Gikas"). Claim 21 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Zajac in view of Bennett and further in view of Armstrong et al, "The best parameter subset using the Chebychev curve fitting criterion", *Mathematical Programming*, Vol. 27, No. 1, September 1983, pgs. 64-74 ("Armstrong").

Like claim 1, claim 23 has been amended to now include wherein the navigation data comprise vectors of position, velocity and acceleration. Neither Zajac nor Bennett nor Brunet nor Cretin nor Saban nor Riley nor Gikas nor Armstrong, alone or in combination, teaches, discloses or suggests this limitation. Since claims 4-8, 16-17, 20-21 and 53 depend from claim 1, and since neither Zajac nor Bennett nor Brunet nor Cretin nor Saban nor Riley nor Gikas nor Armstrong, alone or in combination, teaches, discloses or suggests all the limitations of claim 1, claims 4-8, 16-17, 20-21 and 53 are therefore also patentable over Zajac, Bennett, Brunet, Cretin, Saban, Riley, Gikas and Armstrong. Withdrawal of the rejection is respectfully requested.

With regard to claim 6, the Examiner takes the position that Cretin teaches obtaining error states associated with one or more sensors that measure the environmental data in its abstract. (See Office Action, page 17). Cretin's abstract is reproduced below for the Examiner's convenience.

> A device is provided for acquiring data coming from sensors distributed in several probes which may be anchored in a well or borehole and transmission thereof to a central control and recording system, including a remote control assembly for checking operating parameters. An acquisition apparatus includes a main multiplexer for seismic channels and an auxiliary multiplexer. **The control assembly includes different modules delivering signals indicative of the position of the anchorage arms, of the operating temperature, of the power supply voltage, etc, means for testing the sensors and the seismic channels, and means for detecting any malfunction in the advance of the probes along the borehole.** Different lines connected to the auxiliary multiplexer transmit the signals delivered by the control assembly.
> (Cretin, Abstract, Emphasis Added).

As shown above, Cretin does not teach using predicted residuals to estimate error states associated with sensors that measure environmental data. In contrast, Cretin delivers signals indicative of the position of anchorage arms, an operating temperature and a power supply voltage to detect a malfunction. These signals are not the same as predicted residuals. Predicted residuals are related to a difference between a desired coordinate position and an actual coordinate. (See claim 25). Cretin does not mention predicted residuals anywhere in its disclosure. This difference provides an additional reason why claim 6 is patentable over Zajac, Bennett and Cretin.

Claim 8 has been amended to now include "automatically validating the calculated drive commands." Support for the amendment may be found throughout the specification, including pages 43-45. With regard to claim 8, the Examiner takes the position that Saban teaches validating and executing drive commands in column 4, lines 21-24. (See Office Action, page 18). The relevant portion of Saban is reproduced below for the Examiner's convenience.

> The illustrated system further includes a guidance command generator system 16. This system receives both the data from the signal processing system 8, and also the alarm status from the alarm decision system 12, and body angles from the inertial navigation system 10. If an imminent danger is present, meaning that at the current velocity and heading of the

aircraft a collision is certain in a short time with respect to the pilot response time, the guidance command generator system 16 generates an emergency escape flight guidance command to the autopilot, and a strong audio-visual warning display to the pilot. **The pilot may accept the command and validate it, or may override the command with manual flight commands to avoid the obstacle and to stop the warning signals.**
(Saban, column 4, lines 10-24).

As shown above, Saban does not teach automatically validating the calculated drive commands. In contrast, Saban uses a pilot to validate its drive commands. A pilot's validated commands are not the same as drive commands that are automatically validated. This difference provides an additional reason why claim 8 is patentable over Zajac, Bennett and Saban.

Claim 26 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Zajac in view of Bennett and further in view of US Patent No. 6,292,436 ("Rau"). Claim 31 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Zajac in view of US Patent No. 6,681,710 ("Semb"). Applicants believe that the Examiner intended to reject claim 31 further in view of Bennett as well because the Examiner refers to Bennett in the rejection to claim 31. As such, Applicants assume that the rejection to claim 31 was made in view of Bennett as well.

Neither Zajac nor Bennett nor Rau nor Semb, alone or in combination, teaches or suggests wherein the desired coordinate positions achieve a target shape for the seismic survey spread elements, as recited in claim 25. Since claims 26 and 31 depend from claim 25 and since neither Zajac nor Bennett nor Rau nor Semb, alone or in combination, teaches, discloses or suggests all the limitations of claim 25, claims 26 and 31 are therefore also patentable over Zajac, Bennett, Rau and Semb. Withdrawal of the rejection is respectfully requested.

Claims 32-37 and 61 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Zajac in view of US Patent No. 6,088,298 ("Onat"). Applicants believe that the Examiner intended to reject these claims further in view of Bennett as well because the Examiner refers to Bennett in the rejection to these claims. As such, Applicants assume that the rejection to claims 32-37 and 61 were made in view of Bennett as well.

Onat is generally directed at activating one of a plurality of subsets of transducer elements that is defined by a pattern throughout an array of activated members of the elements and non-activated members of the elements. (See Onat, Abstract). With regard to claims 32 and 37, the Examiner takes the position that Onat teaches activating only a selected portion of the sources that are at the proximities of the desired cross line positions in column 2, lines 55-56 and lines 61-63. (See Office Action, page 23). In addition to the Examiner's cited portion of Onat, column 1, lines 13-16 of Onat is provided below to place Onat in its proper context.

> The present invention **relates generally to sonar arrays**, and more particularly to modifying or setting the operational center frequency of an array by selective **activation of transducer elements** in the array.
> (Onat, column 1, lines 13-16, Emphasis Added).

> Referring now to the drawings, and more particularly to FIG. 1, a first embodiment of the present invention will be described where a two-dimensional M×N array 10 of **square transducer elements 12** is shown. For simplicity of illustration, each of elements 12 is shown touching neighboring elements. However, as is known in the art, each of elements 12 are slightly spaced from neighboring elements by an amount dependent on the particular application. This particular intra spacing is not a factor in the present invention. The row and column intra spacing between centers of neighboring elements is d. Each element's identity in array 10 is denoted by E_{MN} where M is a row number and N is a column number. Electrically coupled to each element 12 is a controller 14 for activating and deactivating selected members of elements 12 as controlled by either an operator input 16 or a programmed instruction set 18 coupled to controller 14.

> In operation of the device of the present invention, controller 14 **activates a pattern of activated members of elements 12 viewed or beamformed in a particular direction**. The pattern and its beamforming direction sets the operational center frequency of array 10. The activated set of elements 12 have a uniform on-center spacing between adjacent activated elements in the beamforming direction throughout the array. In FIG. 1, controller 14 **activates members of elements 12 (indicated by stippling) along the diagonal staves of array 10**. A stave is defined as contiguous elements in a line such as a diagonal of array 10.
> (Onat, column 2, lines 54-64, Emphasis Added).

As shown above, Onat does not teach activating a selected portion of the **sources**, as recited in claims 32 and 37. In contrast, Onat teaches activating a pattern of

transducer elements in order to modify or set the operational center frequency of sonar arrays. (See Onat, column 1, lines 13-16). Transducer elements, however, are not the same as seismic sources. Onat never mentions seismic sources anywhere in its disclosure. This argument was presented in the Response to Office Action filed March 7, 2011. However, the Examiner has not responded to this argument in the current Office Action. Applicants therefore request that a response be provided in the next office action or an allowance for claims 32-37 and 61.

Claims 47, 62, 64 and 65 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Zajac in view of Bennett and further in view of US Patent Application No. 2005/0180263 ("Lambert"). Like claims 45 and 49, claim 47 has been amended to now include "controlling a shape of the seismic survey spread by coordinating the positioning of the vessel control elements and the source control elements based on the estimated positions." Neither Zajac, nor Bennett nor Lambert, alone or in combination, teaches or suggests this limitation, as recited in claims 45, 47 and 49. Further, neither Zajac nor Bennett nor Lambert, alone or in combination, teaches or suggests "wherein the navigation data comprise vectors of position, velocity and acceleration," as recited in claim 1. Since claims 62, 64 and 65 depend from claims 1, 45 and 49, and since neither Zajac nor Bennett nor Brunet nor Lambert, alone or in combination, teaches, discloses or suggests all the limitations of claims 1, 45 and 49, claims 62, 64 and 65 are therefore also patentable over Zajac, Bennett and Lambert. Withdrawal of the rejection is respectfully requested.

Claims 51 and 68 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Zajac in view of Bennett in view of Hocquet. Like claims 45, 47 and 49, claim 51 has been amended to now include "controlling a shape of the seismic survey spread by coordinating the positioning of the first vessel control element, the second vessel control element, the first source control element and the second source control element based on the estimated positions." Neither Zajac nor Bennett nor Hocquet, alone or in combination, teaches, discloses or suggests this newly added limitation. Since claim 68 depends from claim 25 and since neither Zajac nor Bennett nor Hocquet, alone or in combination, teaches, discloses or suggests all the limitations of claim 25, claim 68 are therefore also patentable over Zajac, Bennett and Hocquet.

Claims 56-58 and 67 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Zajac in view of Bennett, Onat and Lambert. Neither Zajac nor Bennett nor Onat nor Lambert, alone or in combination, teaches, discloses or suggests "activating a selected portion of the sources," as recited in claim 32. Since claims 56-58 and 67 depend from claim 32 and since neither Zajac nor Bennett nor Onat nor Lambert, alone or in combination, teaches, discloses or suggests all the limitations of claim 32, claims 56-58 and 67 are therefore also patentable over Zajac, Bennett and Lambert.

Claim 60 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Zajac in view of Bennett and further in view of U.S. Patent No. 7,047,898 ("Petersen"). Neither Zajac nor Bennett nor Petersen, alone or in combination, teaches, discloses or suggests "controlling a shape of the seismic survey spread by coordinating the positioning of the vessel control elements, the source control elements and the streamer control elements," as recited in claim 59. Since claim 60 depends from claim 59 and since neither Zajac nor Bennett nor Petersen, alone or in combination, teaches, discloses or suggests all the limitations of claim 59, claim 60 is therefore also patentable over Zajac, Bennett and Petersen. Withdrawal of the rejection is respectfully requested.

In conclusion, the references cited by the Examiner, neither alone nor in combination, teach, show, or suggest the claimed invention. Having addressed all issues set out in the office action, Applicants respectfully submit that the claims are in condition for allowance and respectfully request that the claims be allowed.

Respectfully submitted,

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